Dynamic Origin of Stripe Domains

Scientific Achievement

Stripe domains are a common feature of many physical systems: sand dunes, crystal twinning, ferroelectric domains, polymer self-organization and magnetic domains. Contrary to common wisdom we show that energy minimization does not account for the stripe domain pattern in a cobalt bar. Instead we show that the origin of the pattern is a soft magnetic excitation.

First we showed that the domain structure at remanence is not the lowest energy state. Then, via calculations of magnetic spin waves in the cobalt bar, we show that the lowest frequency bulk mode of the system has the same period as the domain pattern at remanence. Moreover the frequency of this mode goes to zero at the same field at which the order parameter of the stripe domains appears. These two observations lead to the conclusion that stripe domain patterns observed at remanence are not due to an energy minimization process but are due to a second order phase transition involving a soft magnon.

Significance

The origin of stripe domains in a cobalt bar have been shown to originate from a soft spin-wave mode and not from energy minimization considerations. Although the calculations were done for a magnetic sample, it is likely that the same process will occur in many other systems exhibiting stripe domains. Given the importance of stripe domains in technological applications – in particular magnetism and ferroelectricity – the insight provided by this study could have wide ranging implications for dealing with and designing stripe domain structures. Ongoing research is directing at establishing the general nature of soft-mode-induced magnetic phase transitions. Although just published (*Phys. Rev. Lett*. **96**, 017201 (2006)), the work has already generated an invitation to present the results at *Hitachi Corp*.. where stripe domains are a common feature of perpendicular recording media.

Performers

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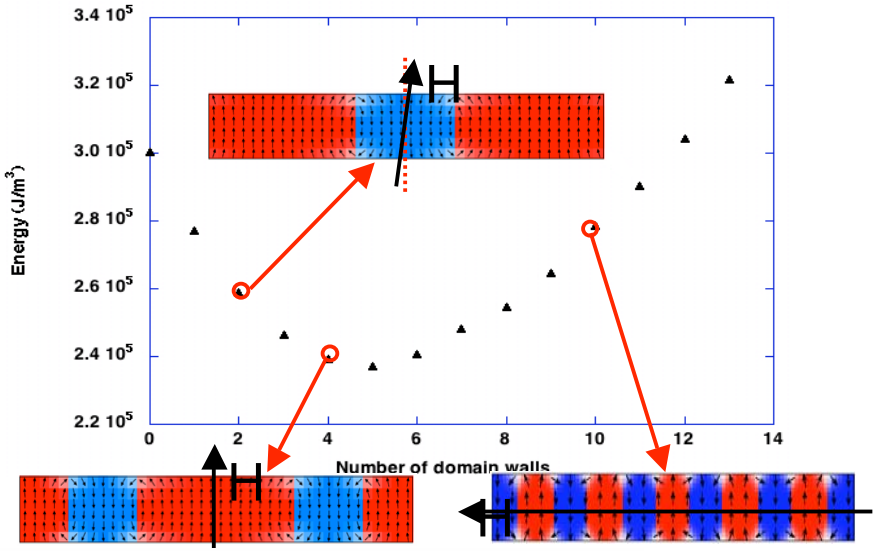
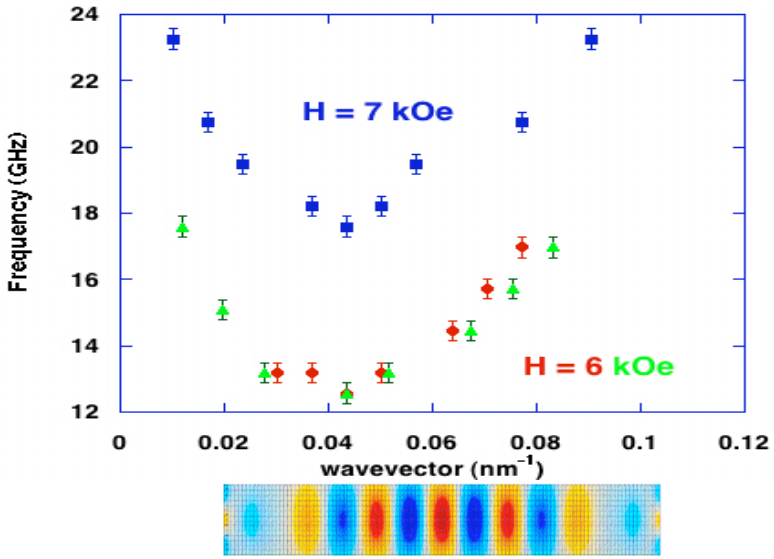
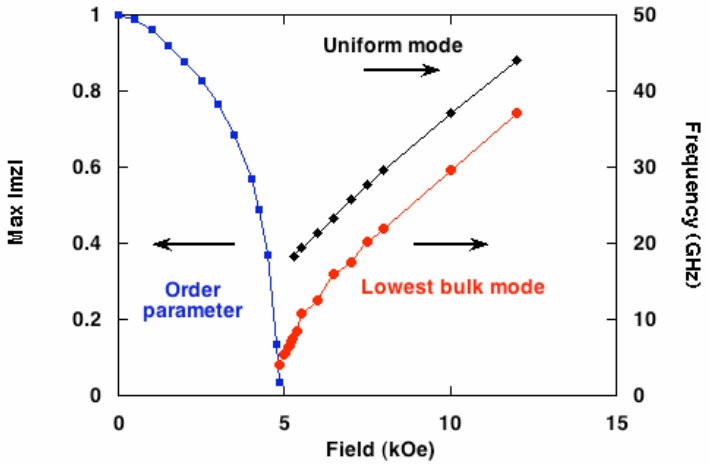
Dynamic Origin of Stripe Domains



Domain formation is history dependent. It is not the minimum energy state



The lowest frequency mode has the profile of the domains at remanence



We find that stripe domain order parameter goes to zero simultaneously with the frequency of low frequency spin mode. Thereby confirming that the origin of stripe domains is not energy minimization but a dynamical soft mode.

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